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Cannonball River Panels 01P-03P

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Mott, Hettinger County, North Dakota, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers (COE), for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-EMW-E-1153, Project Order No. 1, Amendment No. 27. This study was completed in November 1984.

1.3 Coordination

The time and cost meeting was held in Mott on July 25, 1983. The meeting was attended by Mott city officials, representatives of the North Dakota State Water Commission, and the COE.

Coordination was established between the U.S. Geological Survey (USGS), Hettinger County, FEMA, the City of Mott, the State of North Dakota, the U.S. Soil Conservation Service, and the U.S. Bureau of Reclamation to obtain information pertinent to the study.

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2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Mott, Hettinger County, North Dakota, and its extraterritorial zoning limits. The area of study is shown on the Vicinity Map (Figure 1).

A detailed study was made of the Cannonball River from approximately 2 miles downstream from South Dakota State Highways 8 and 21 to approximately 2 miles upstream of the Brown Avenue Bridge.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 1984.

2.2 Community Description

The City of Mott, the county seat of Hettinger County, is located in southwestern North Dakota approximately 100 miles upstream from the mouth of the Cannonball River. The city was originally developed along the northern side of the Cannonball River and extended up from the flood plain to the higher land overlooking the river. West Mott, which occupies part of the flood plain south of the river, was a later addition to the city. The original part of Mott contains the city's main business district and some residential areas. West Mott is comprised of business, residential, and industrial areas. Mott, which had a 1980 population of 1,315 (Reference 1), serves as one of the principal shopping and trading centers for a large ranching and farming area.

Climatological records at the Mott weather station show mean monthly temperatures varying from 71.4°F in summer to 10.2°F in winter. The growing season averages 121 days, with the average date of the latest killing frost occurring on May 18 and the earliest on September 16. The mean annual precipitation is 15.77 inches.

The Cannonball River rises in southwestern North Dakota in Slope County near Amidon, North Dakota, and flows eastward 150 miles across North Dakota until it reaches the Missouri River near the Town of Cannon Ball, North Dakota. The drainage basin encompasses an area of 4,300 square miles and ranges in elevation from 3,060 feet above the National Geodetic Vertical Datum (NGVD) at the headwaters to 1,590 feet NGVD at the Missouri River.

The Cannonball River in the vicinity of Mott has an average bed slope of 2.8 feet per mile, a drainage area of 748 square miles,

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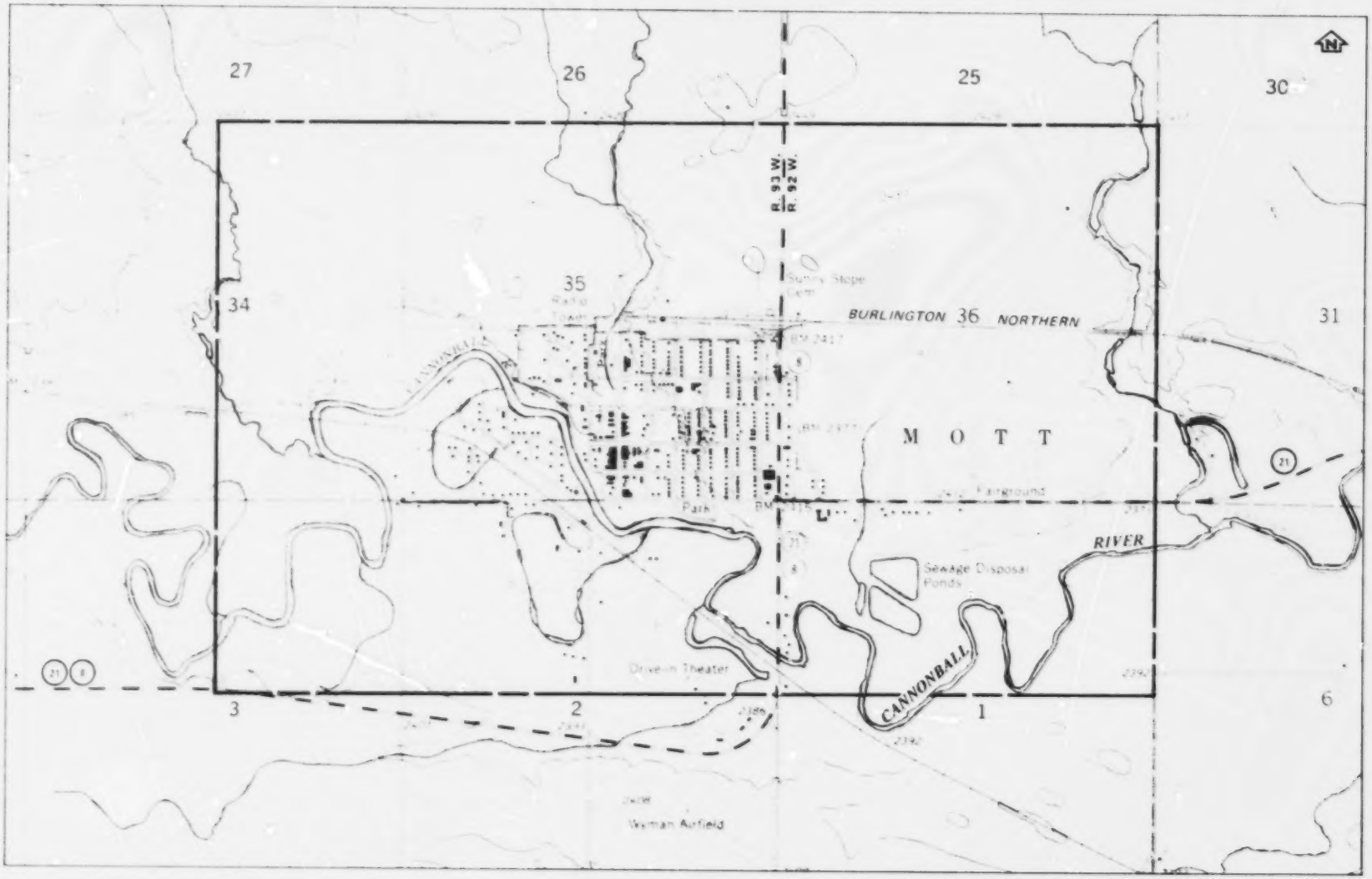

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

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and an average elevation of 2,380 feet NGVD. The river channel has a depth ranging from 15 feet to 20 feet and a top width ranging from 50 feet to 150 feet. The area flooded by the 100-year flood ranges in width from 650 feet to 3,090 feet, with the average width being near 1,600 feet.

Mott is served by South Dakota State Highways 8 and 21, as well as by the Burlington Northern Railroad.

2.3 Principal Flood Problems

In the past, flooding at Mott has been aggravated by the formation of ice jams which typically form at bridges. These ice jams often create localized high velocity flows which scour around bridge piers and abutments, and weaken the structures. The ice jams back water into the urban areas; in some cases, water flows around the jams and passes through the developed areas. Floating ice is especially dangerous and produces an added hazard. Potential flood damage at Mott ranges from relatively little, such as basement flooding, to relatively heavy from flooding of considerable depth.

Commercial and residential structures, grain storage facilities, a church, public buildings, and farms are located in the Cannonball River flood plain and would be subject to damage in the event of a large flood. Much of the existing development with the Cannonball River flood plain has received flood damage in previous years.

Usually, flooding at Mott has been caused by runoff from rapid snowmelt. However, other meteorological events, such as heavy general rains or intense local thunderstorms, could create more severe flooding than that previously experienced. Notable flooding occurred along the Cannonball River at Mott in March 1943, April 1950, April 1952, March 1972, March 1978, and April 1982. In 1943, an ice jam formed at the concrete arch bridge and caused flooding in the western half of the town. Several homes and businesses were flooded and approximately 500 persons were evacuated. The greatest recorded flood occurred in April 1950 from rapid snowmelt and ice jams. Ice jams formed at the concrete arch bridge and at the Chicago, Milwaukee, St. Paul, and Pacific Railroad bridge located at the western edge of Mott. Many homes and businesses were damaged, the railroad tracks inundated, telephone service disrupted, and a water main supplying 60 homes broken. Figures 2 and 3 show scenes of the April 1950 flood.

2.4 Flood Protection Measures

There are no major flood control structure n the Cannonball River or its tributaries. There are some 11 dams on intermittent tributaries, but these have l le or no effect on the Cannonball River peak discharges at Mc .

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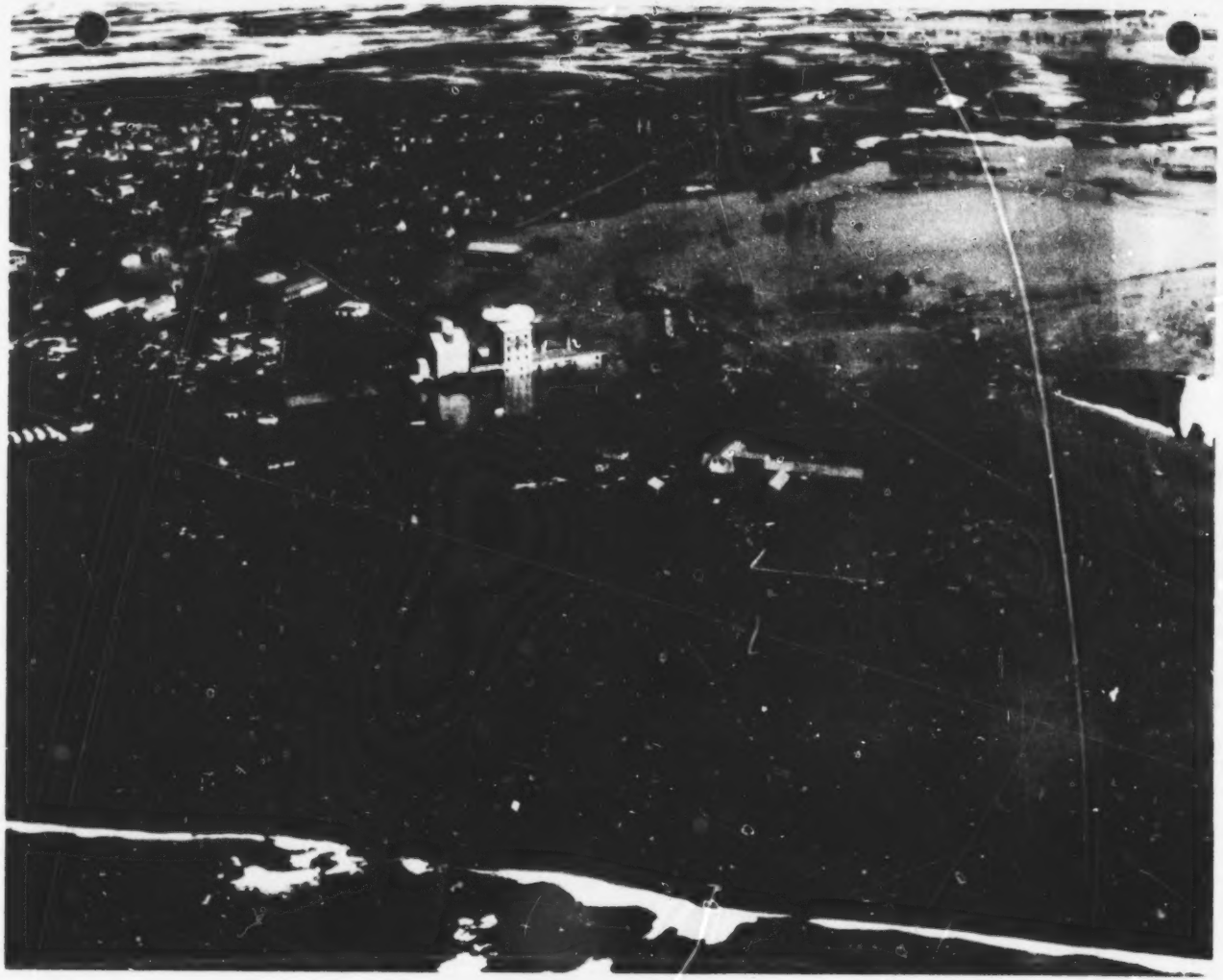

Figure 2. View looking northeast at Mott during the April 1950 flood.

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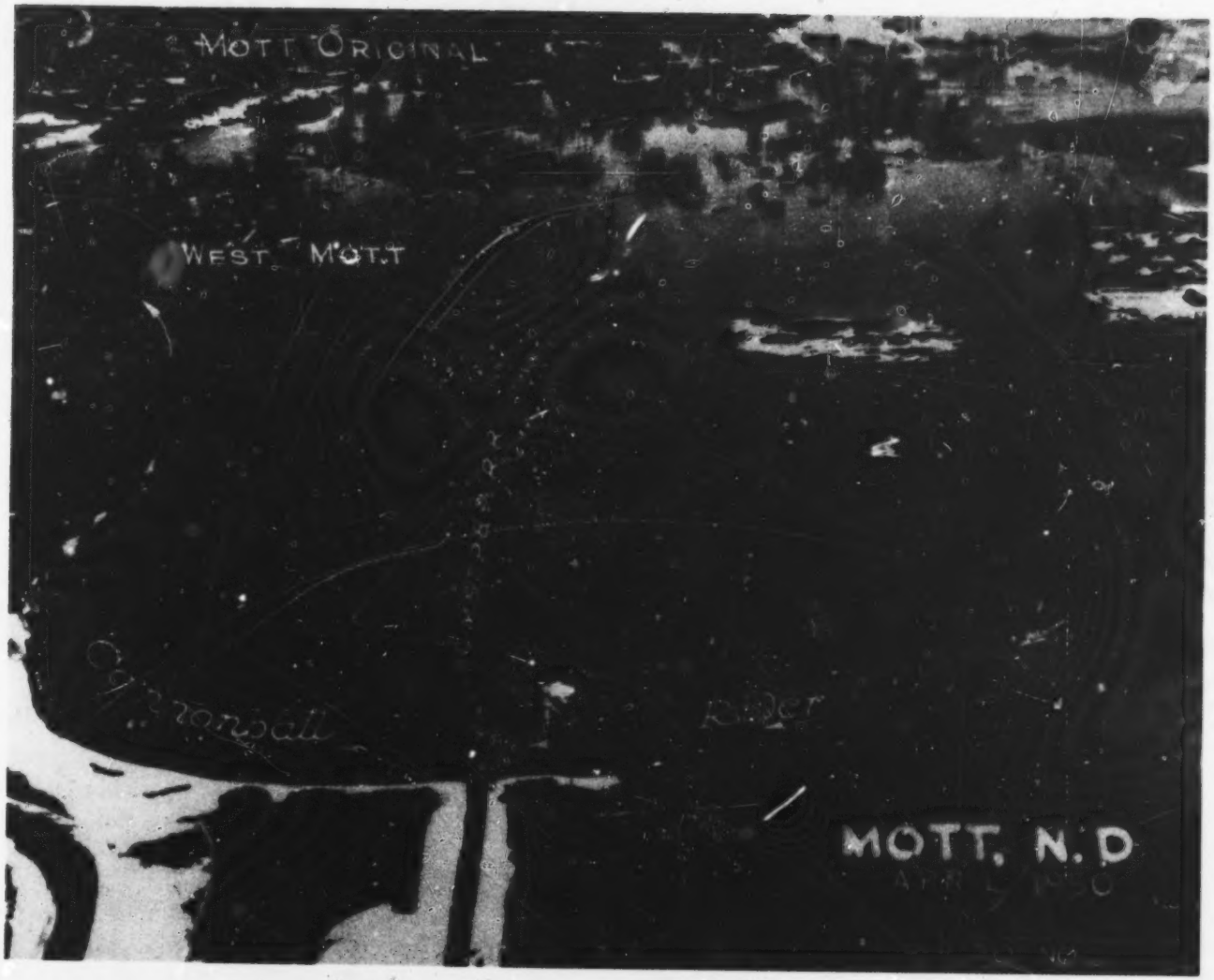

Figure 3. View looking east at Mott during the April 1950 flood.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out for a 1980 COE study (Reference 2) and were done to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community. The discharges in this study are the same, except that the expected probability adjustment was removed.

Peak discharge-probability area relationships for the Cannonball River at Mott were developed according to the criteria contained in U.S. Water Resources Council Bulletin 17A, "Guidelines for Determining Flood Flow Frequency" (Reference 3). Stream gaging information is not available for the 748-square-mile drainage area at Mott. It was necessary to base the discharge-probability relationship on regional curves developed from a statistical analysis of the stream gage record for the three USGS gages located on the main stem of the Cannonball River at Regent, Bentley, and Breien, North Dakota. The stream gage station at Regent, located upstream from Mott, has a drainage area of 580 square miles and a 29-year period of record as of 1979. The stream gaging stations at Bentley and Breien are both located downstream from Mott. As of 1979 Bentley and Breien had drainage areas of 1,140 and 4,100 square miles with periods of record of 36 and 63 years, respectively. The discharge-probability relationship at Mott was constructed using the regional relationship of the specific frequency discharges versus the drainage area developed at Breien, Bentley, and Regent. The values have been adjusted for partial duration. Peak discharge-probability relationships for the Cannonball River are shown in Table 1.

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Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Cannonball River					
At Mott	748	8,500	17,000	22,000	36,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations of floods of the selected recurrence intervals were computed by the COE HEC-2 step-backwater computer program (Reference 4).

The cross sections for the backwater analyses of the Cannonball River were field surveyed.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

A main channel roughness factor (Manning's "n") of 0.030 was assigned by field inspection, engineering judgment, and comparing completed flood boundaries with past flood boundaries. Roughness values for the flood plain ranged from 0.045 to 0.100.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals (Exhibit 1). Starting water-surface elevations for the Cannonball River were obtained from a rating curve developed from the COE study (Reference 2).

The hydraulic analyses for this study are based on flow adjusted for ice effects. The discharges at Mott were adjusted for the effects of ice on the river based on a rating curve at the Bentley gage and the historical effect of ice at the gage. Stage versus frequency curves at the USGS streamflow gage at Bentley, North Dakota, for open-water and ice-affected flows were used to establish a combination open-water/ice-affected stage versus frequency curve. The comparison of the open-water curve provides the difference in stage between the two curves. This difference in stage was then equated to an increment of open-water discharge at the Bentley gage. These increments were then added to the appropriate flood discharges in the open-water hydraulic model. This yielded flood profiles which reflected the combination of open-water and ice affects. Flood boundaries are based on the effects of ice on the river, while the floodway is based on non-ice-affected conditions.

All elevations are referenced to the NGVD. Elevation reference marks used in this study are shown on the maps.

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4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet (Reference 5).

The 100- and 500-year flood plain boundaries, based on ice effects, are shown on the Flood Boundary and Floodway Map (Exhibit 2). These boundaries were verified by comparing past flood photographs and previous studies (Reference 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross

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sections for each stream segment for which a floodway is computed (Table 2).

The floodway computed does not consider the effects of ice on the river.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.

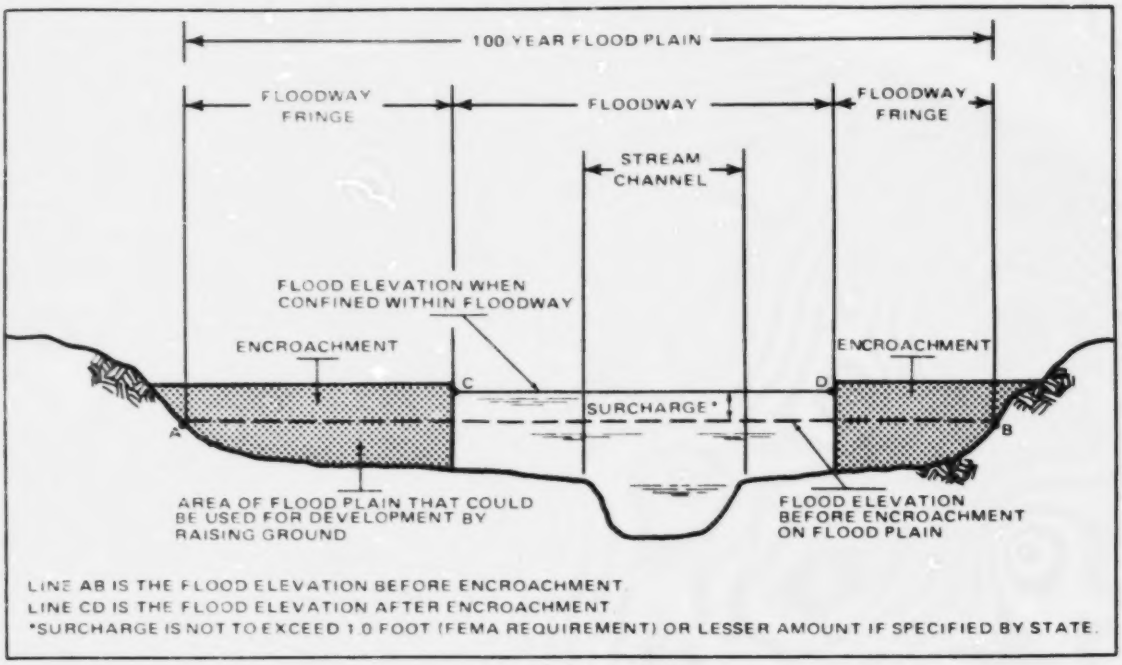
100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 4. Floodway Schematic

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Cannonball River								
A	970	250	2,878	7.6	2,370.0	2,370.0	2,370.9	0.9
B	2,710	538	3,988	5.5	2,372.4	2,372.4	2,372.8	0.4
C	6,030	667	5,622	3.9	2,374.0	2,374.0	2,374.7	0.7
D	7,340	880	5,152	4.3	2,374.6	2,374.6	2,375.2	0.6
E	9,380	785	4,911	4.5	2,375.6	2,375.6	2,376.3	0.7
F	11,240	1,160	6,424	3.4	2,377.0	2,377.0	2,377.4	0.4
G	11,400	1,145	8,218	2.7	2,377.8	2,377.8	2,377.8	0.0
H	12,030	1,325	7,916	2.8	2,377.8	2,377.8	2,377.9	0.1
I	14,000	1,387	9,877	2.2	2,378.2	2,378.2	2,378.5	0.3
J	14,390	1,171	7,704	2.9	2,378.4	2,378.4	2,378.6	0.2
K	15,190	900	5,969	3.7	2,378.5	2,378.5	2,378.8	0.3
L	16,060	600	4,311	5.1	2,379.0	2,379.0	2,379.3	0.3
M	16,300	700	4,264	5.2	2,379.2	2,379.2	2,380.1	0.9
N	17,100	1,095	7,122	3.1	2,379.5	2,379.5	2,380.4	0.9
O	18,220	1,167	7,898	2.8	2,380.1	2,380.1	2,380.8	0.7
P	20,020	1,275	9,068	2.4	2,380.7	2,380.7	2,381.4	0.7
Q	22,050	373	3,824	5.8	2,380.4	2,380.4	2,381.2	0.8
R	25,260	980	4,980	4.4	2,382.5	2,382.5	2,383.0	0.5
S	27,300	580	5,711	3.9	2,383.5	2,383.5	2,384.2	0.7
T	28,540	518	5,895	3.8	2,383.7	2,383.7	2,384.6	0.9

[1] Feet Above Downstream Limit of Detailed Study

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

FLOODWAY DATA

12

CANNONBALL RIVER

zone designations for each flooding source studied in detail affecting the City of Mott.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the City of Mott are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10-and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Cannonball River Reach 1	**0001**	**-3.7**	**-0.9**	**1.8**	**035**	**A7**	**Varies - See Map**

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

FLOOD INSURANCE ZONE DATA

CANNONBALL RIVER

Zone A7:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flood hazard; not subdivided.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Mott is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

6.0 OTHER STUDIES

A Preliminary Flood Insurance Study was prepared for the City of Mott by the COE, Omaha District, in June 1976 (Reference 6). This study covered only the city limits. The Omaha District also performed a restudy of the authorized flood control project at Mott in February 1980 (Reference 2).

This Flood Insurance Study supersedes the previously published Preliminary Flood Insurance Study for Mott dated June 1976 (Reference 6).

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7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Building 710, Denver Federal Center, Lakewood, Colorado 80225.

8.0 BIBLIOGRAPHY AND REFERENCES

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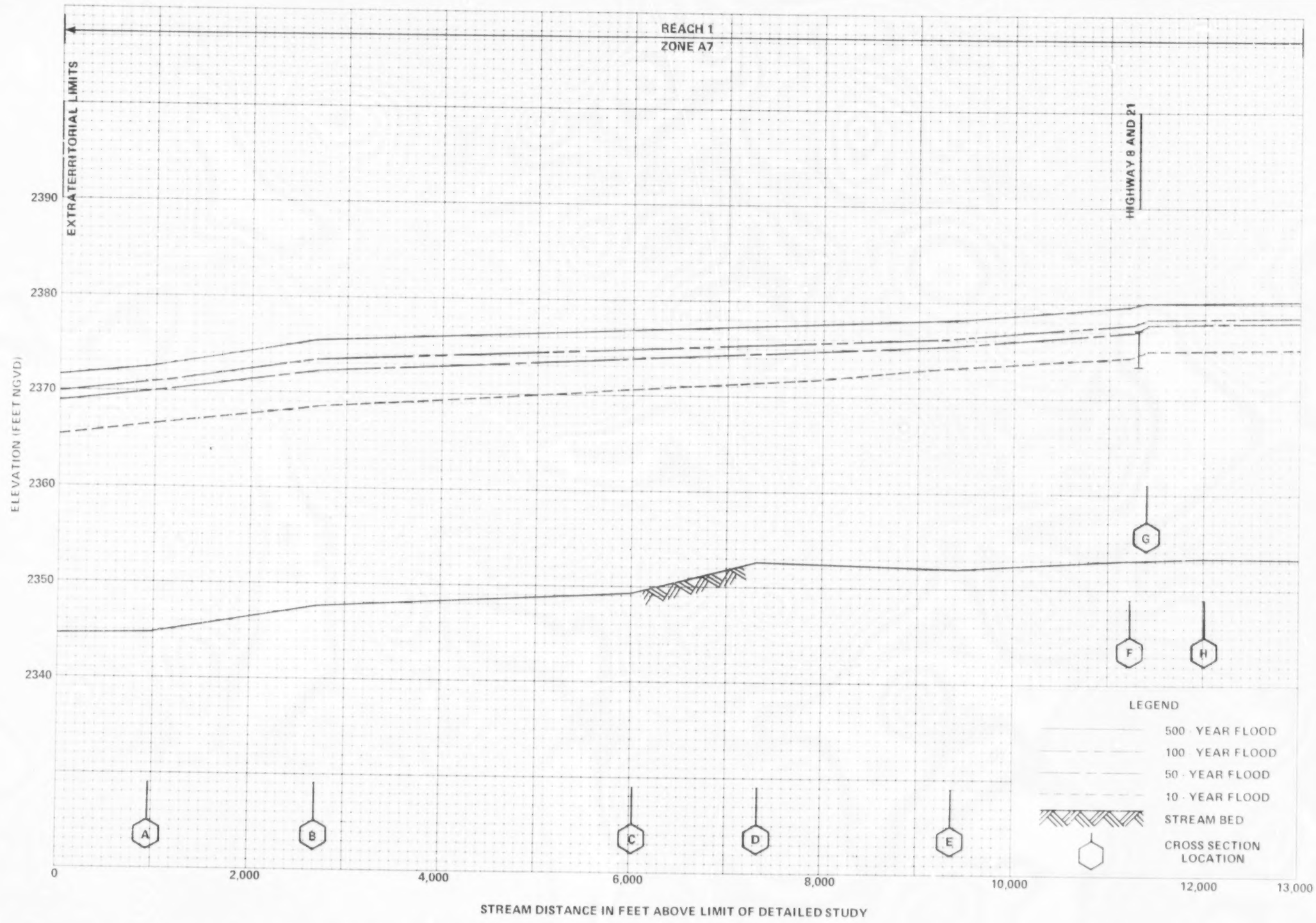

FLOOD PROFILES

CANNONBALL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

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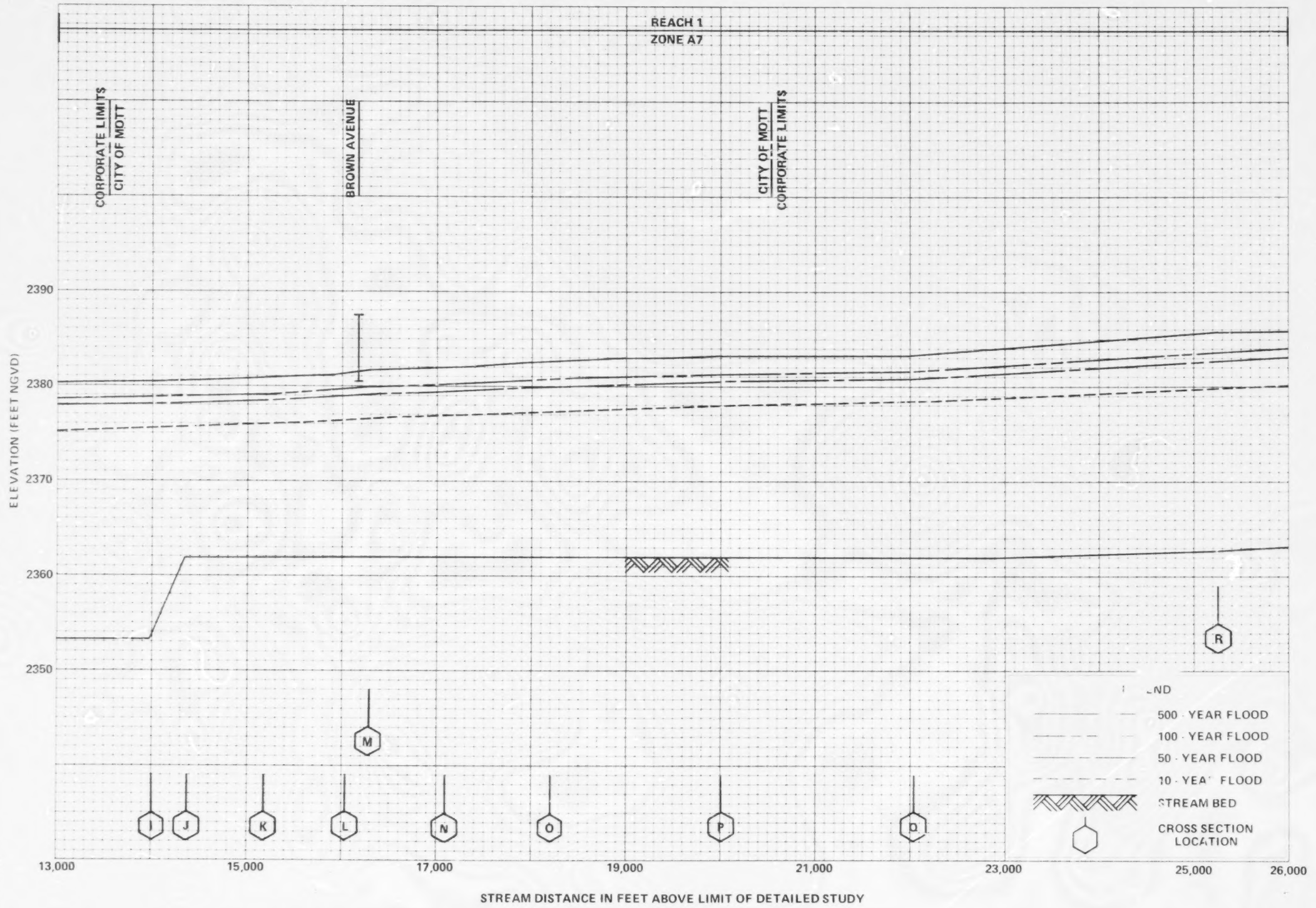

FLOOD PROFILES

CANNONBALL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

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REACH 1
ZONE A7

EXTRATERRITORIAL LIMITS

ELEVATION (FEET NGVD)

2390
2380
2370
2360

S
T

26,000
28,000
29,000

STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY

LEGEND

- 500 - YEAR FLOOD
- 100 - YEAR FLOOD
- 50 - YEAR FLOOD
- 10 - YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

CANNONBALL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOTT, ND
(HETTINGER CO.)

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